

DIII-D Research Program Plans

by
M. Wade

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FY08 Budget Planning Meeting
Washington, DC

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DIII-D Research Program Is Closely Aligned with FESAC Priorities Report Overarching Themes

FESAC Priorities Panel

- Understand matter in the high temperature state
- Create a star on earth
- Develop the science and technology to realize fusion energy

DIII-D Research Objectives

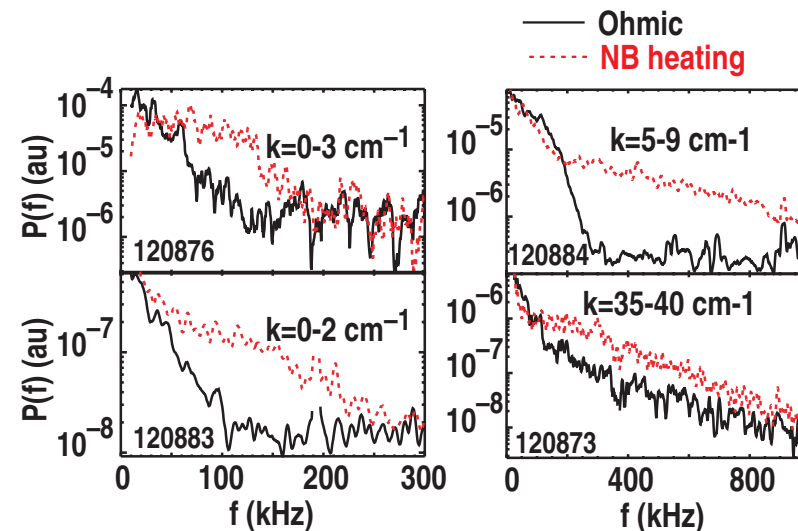
- Advance the science understanding of fusion plasmas in the areas of:
 - Transport
 - Plasma surface interaction
 - Stability
 - Waves and energetic particles
- Enable the success of ITER by providing solutions to key issues and development of advanced scenarios
- Develop the control tools and physics basis for high performance, steady-state tokamak operation

DIII-D Will Provide Important and Timely Research Results on Key Issues for ITER's Design and Operation

- **Provide the physics basis for key ITER design decisions**
 - ELM suppression/control ⇒ Non-axisymmetric coil set
 - RWM stabilization ⇒ Non-axisymmetric coil set
 - NTM stabilization by ECCD ⇒ EC launcher design/modulation
 - Disruption mitigation ⇒ Mitigation system design, thermal loads
 - Tritium retention in carbon PFCs ⇒ Choice of first wall materials
- **Develop and validate integrated scenarios that meet ITER physics objectives and offer potential for an enriched ITER research program**
 - Advanced tokamak development
 - Hybrid scenarios development
 - Transport scaling of conventional ELMing H-mode
- **Develop a predictive understanding of issues key to ITER performance**
 - Physics based transport model – core and pedestal
 - Heat flux control, SOL transport and flow
 - Fast ion physics and instabilities
 - Sawtooth control

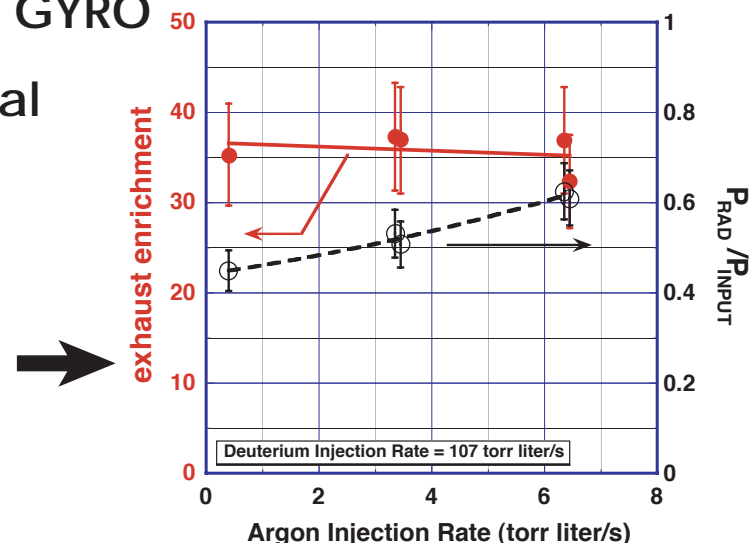
Research Highlights in 2005 Span a Wide Variety of Topical Areas

- Eliminated ELMs using $n=3$ resonant magnetic perturbations without significantly impacting confinement
- Operation stable at the no-wall β limit by preemptively suppressing the $m=2/n=1$ neoclassical tearing mode using ECCD
- Documented a significant discrepancy between the measured poloidal rotation and neoclassical predictions
- Confirmed the universality of the physics of resistive wall mode stabilization by plasma rotation, in joint experiments with JET and NSTX
- Demonstrated that direct penetration of a neutral gas jet to plasma core is not needed for disruption mitigation
- Demonstrated real-time feedback control of the current density profile
- Measured simultaneously turbulence spanning wide range of wave numbers (0-40 cm^{-1})



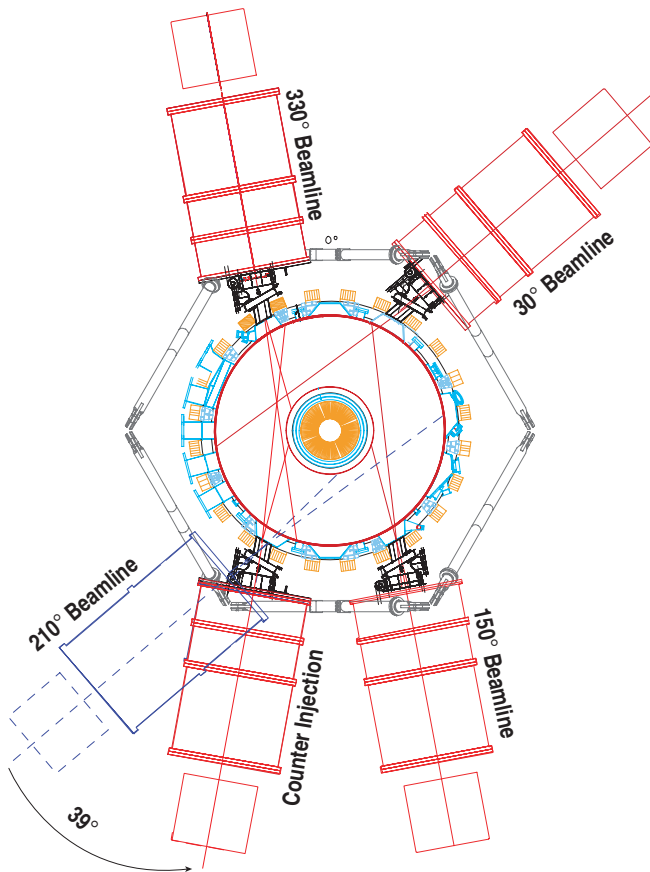
Research Highlights in 2005 Span a Wide Variety of Topical Areas (continued)

- Demonstrated sustained operation near the ideal wall stability limit
- Provided first proof of the existence of low-frequency (Rosenbluth-Hinton) zonal flows in a tokamak
- Observed marked reduction in carbon redeposition in tile gaps and on mirrors at elevated temperatures
- Developed stationary ($t_{dur} > 9 \tau_R$) high performance discharges that scale favorably to ITER
- Discovered correlation between improved transport at rational surfaces and corrugations from zonal flows predicted by GYRO
- Measured the spatial structure and temporal evolution of fast ion-driven instabilities and compared with theory
- Demonstrated compatibility of high performance operation with high radiative fractions ($P_{rad}/P_{inj} > 60\%$) and high impurity enrichment ($\eta_{AR} > 30$)



DIII-D Versatility and Capability Will be Greatly Enhanced by Several Hardware Modifications/Upgrades

- Reorientation of beamline
- EC upgrades
- Lower divertor modification

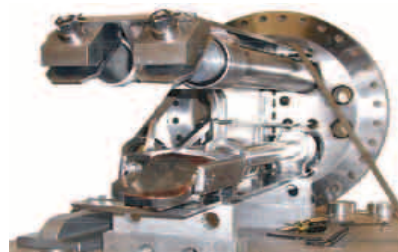


⇒ Rotation control

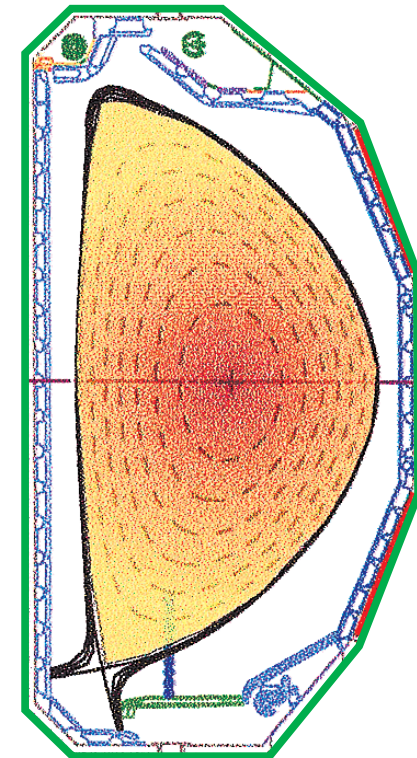


6 gyrotrons
– 4.5 MW
for 10 s

All steerable toroidally
and poloidally



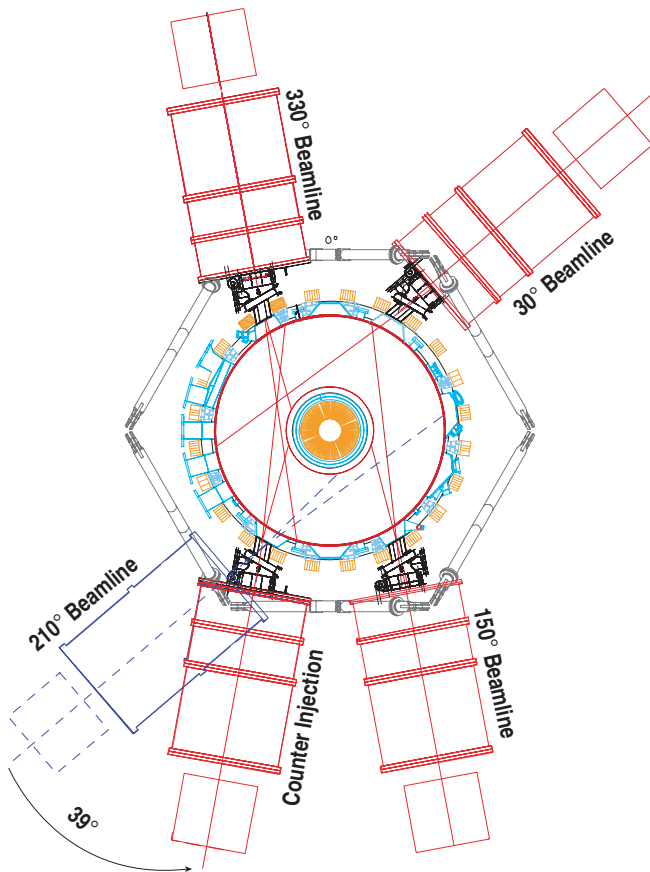
⇒ $J(\rho)$ control, NTM
stabilization,
electron transport



⇒ ITER divertor configuration

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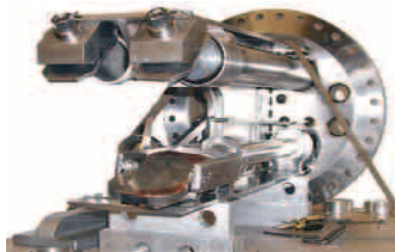


⇒ Rotation control

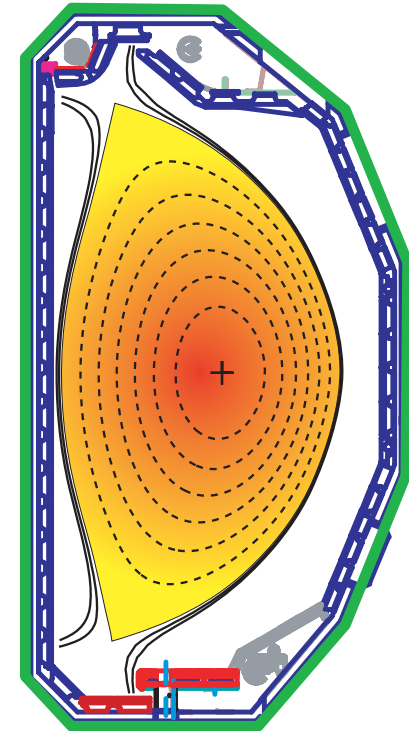


6 gyrotrons
–4.5 MW
for 10 s

All steerable toroidally
and poloidally



⇒ $J(\rho)$ control, NTM
stabilization,
electron transport



⇒ Density control in
double null plasmas

DIII-D Researchers are Strongly Engaged in International Tokamak Physics Activity (ITPA)

— 40 team members, 3 international chairs/co-chairs, 8 US leaders/co-leaders —

Coordination Committee	Oktaý
Erol Oktaý	OFES
Ned Sauthoff	PPPL
Ron Stambaugh	GA

Transport Physics (TP)	Bolton
Ed Doyle	UCLA
Ed Synakowski	LLNL
John Rice	MIT
John Kinsey	Lehigh
Punit Gohil	GA
Dave Mikkelsen-Stell.	PPPL
Michael Kotschenreuther	Texas
Catherine Fiore	MIT
Larry Baylor	ORNL
Wendell Horton	Texas
Chuck Greenfield	GA
T.S. Hahm	PPPL
Bill Nevins	LLNL
Martin Peng	PPPL/ORNL
Ron Waltz	GA
Jim Callen	Wisconsin

Pedestal & Edge Physics (PEP)	Crisp
Tony Leonard	GA
Amanda Hubbard	MIT
Parvez Guzdar	Maryland
Tom Rognlien	LLNL
Mickey Wade	GA
Xueqiao Xu	LLNL
Phil Snyder	GA
Rich Groebner	GA
Rip Perkins	PPPL
Tom Osborne	GA
Jim Drake	Maryland
Ben Leblanc	PPPL

Steady State Operations (SSO)	Oktaý
Tim Luce	GA
Paul Bonoli	MIT
Ron Prater	GA
Chuck Kessel	PPPL
Masanori Murakami	ORNL
Randy Wilson	PPPL
Mike Zarnstorff	PPPL
Pete Politzer	GA
Joel Hosea	PPPL
Cary Forest	Wisconsin

MHD, Disruption and Control (MDC)	Dagazian
Ted Strait	GA
William Heidbrink	UCI
Robert Granetz	MIT
Jon Menard	PPPL
Jerry Navratil	Columbia
Ed Lazarus-Stellarator	ORNL
Chris Hegna	Wisconsin
Eric Fredrickson	PPPL
John Wesley	GA
Steve Jardin	PPPL
Boris Breizman	Texas
Raffi Nazikian	PPPL
Doug Darrow	PPPL
Nicolai Gorelenko	PPPL
Steve Sabbagh	Columbia

Notes:

1. The first five persons in each group are the core members
2. The first person in each group is the U.S. Leader
3. The second person is the U.S. deputy leader
4. The membership is open to all members of the U.S. community
5. Everyone on the list will receive communication on ITPA and be able to contribute to it.

Confinement, Database, and Modeling (CDBM)	Eckstrand
Wayne Houlberg	ORNL
Jim DeBoo	GA
Stan Kaye	PPPL
Joe Snipes	MIT
Robert Budny	PPPL
Tom Casper	LLNL
Craig Petty	GA
Lynda Lodestro	LLNL
Glenn Bateman	Lehigh
Dale Meade	PPPL
Arnold Kritz	Lehigh
Martin Greenwald	MIT

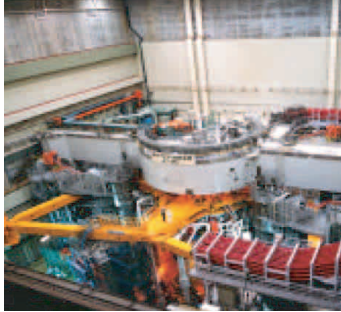
Divertor Physics & Scrape-off-layer (DSOL)	Fingeld
Bruce Lipschultz	MIT
Peter Stangeby	LLNL/GA
Dennis Whyte	Wisconsin
Sergei Krasheninnikov	UCSD
Max Fenstermacher	LLNL
Rajesh Maingi	ORNL
Ali Mahdavi	GA
Daren Stotler	PPPL
John Hogan	ORNL
Charles Skinner	PPPL
Henry Kugel	PPPL
Jim Strachan	PPPL
Mathias Groth	LLNL
Steve Lisgo	U Toronto

Diagnostics	Markevich
Dave Johnson	PPPL
Rejean Boivin	GA
Tony Peebles	UCLA
George McKee	Wisconsin
Glen Wurden	LANL
Don Hillis	ORNL
Ray Fisher	GA
Ken Young	PPPL
Jim Terry	MIT

DIII-D Versatility Promotes ITPA/IEA Joint Experiments*

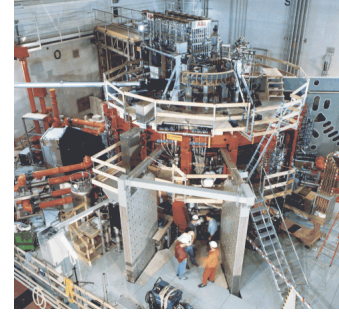
With Fusion Facilities Worldwide

JT-60U



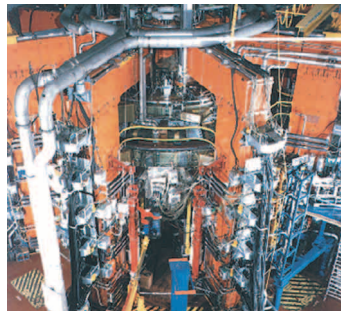
- Advanced Tokamak ✓
- Hybrid ✓
- QH-mode ✓
- ITB formation ✓
- Effects of rotation ✓

ASDEX-Upgrade



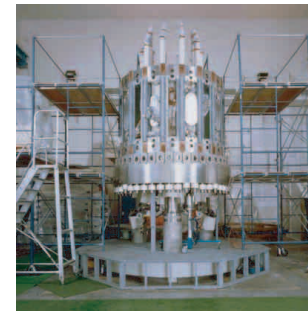
- Hybrid ✓
- Pedestal
- NTM
- Edge/Pedestal ✓

JET



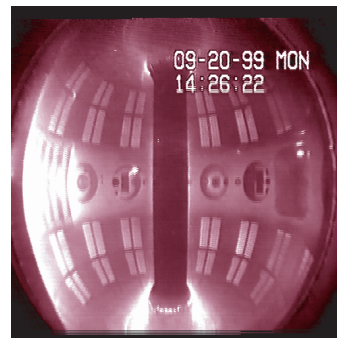
- Transport scaling ✓
- Hybrid ✓
- NTM ✓
- Advanced tokamak ✓
- Disruptions
- RWM

Alcator C-Mod



- Pedestal
- Momentum transport
- Edge/divertor
- Disruptions ✓

NSTX



- Fast ion instabilities ✓
- Pedestal ✓
- Transport
- Plasma control ✓
- RWM ✓

✓ = Planned participation by
DIII-D staff on external experiment

* = Full list of IEA/ITPA
Joint Experiments attached

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FESAC Priorities Panel

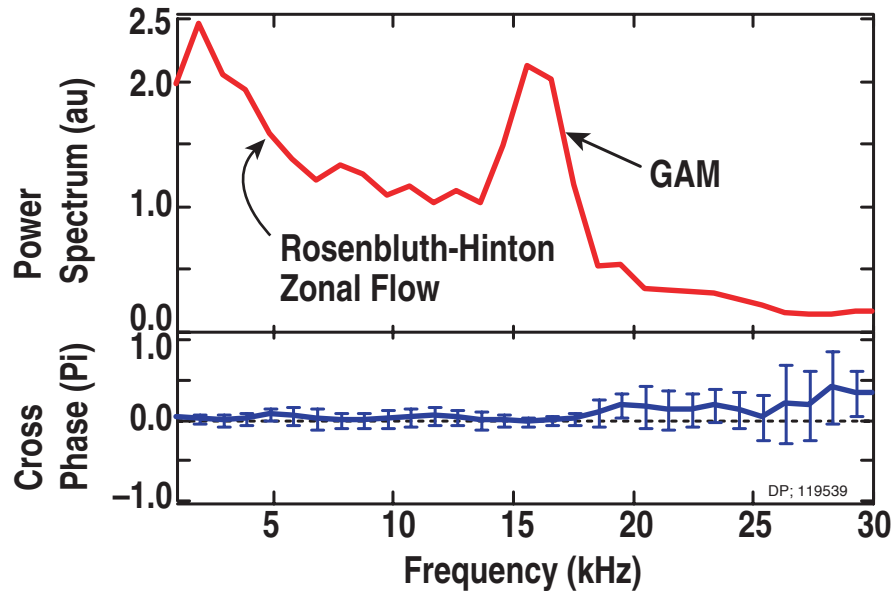
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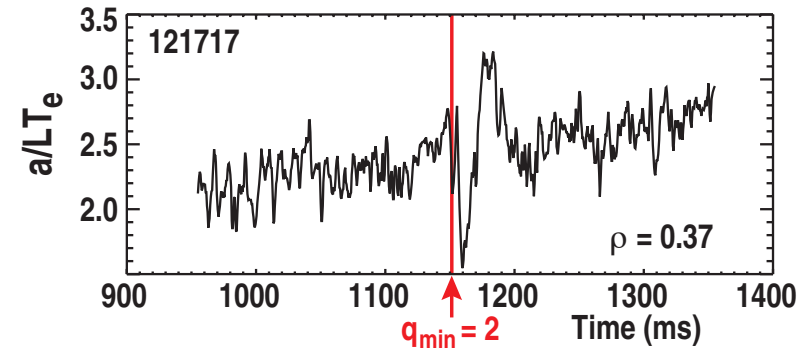
Zonal Flows are an Excellent Example of the Synergism of Experiment and Theory on DIII-D

- BES Measurements Indicate Existence of Low Frequency Zonal Flow

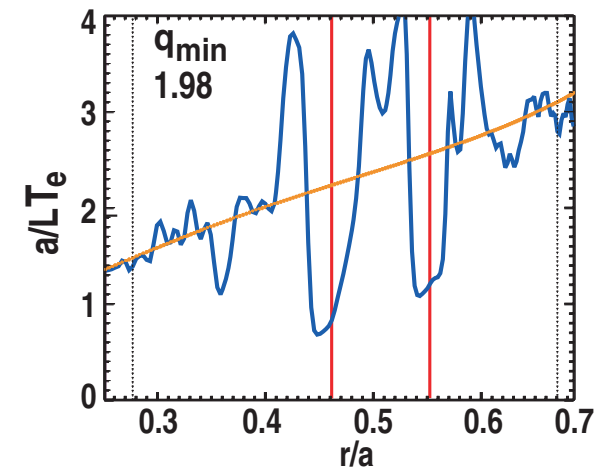


- Long poloidal and short radial correlation lengths are consistent with Rosenbluth-Hinton zonal flow

ECE T_e Gradients



GYRO

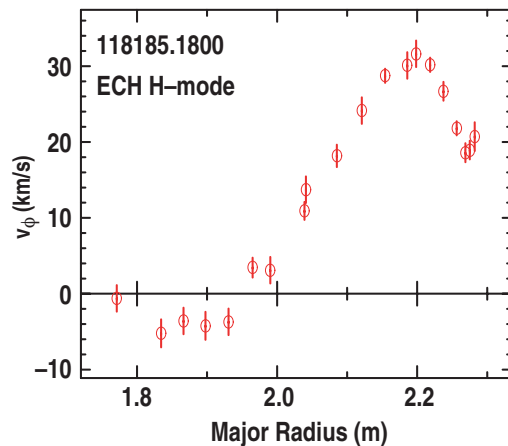


- Corrugations related to zonal flow generation near $q = 2$

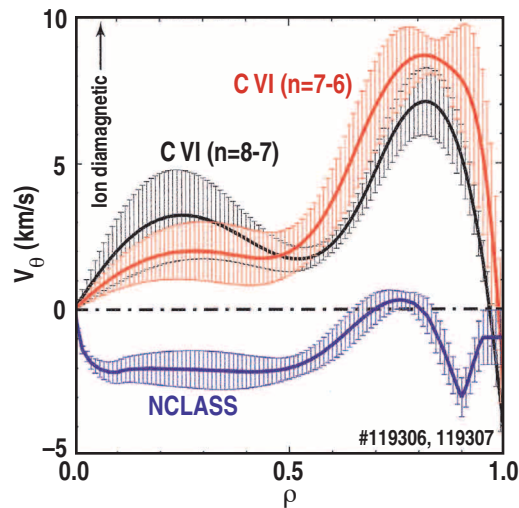
T4. How does turbulence cause heat, particles, and momentum to escape from plasmas?
T5. How are electromagnetic fields and mass flow generated in plasmas?

New Tools Will Enable Investigations of Several Mysteries in Momentum Transport and Related Issues

- Rotation observed without any angular momentum input



- Observed poloidal rotation differs from neoclassical prediction



- Capability of co-, counter-, and balanced NBI will allow assessment of:

Momentum Transport

2006-07: Dependence on torque input (TP-4.2)

2008: Physics of poloidal rotation

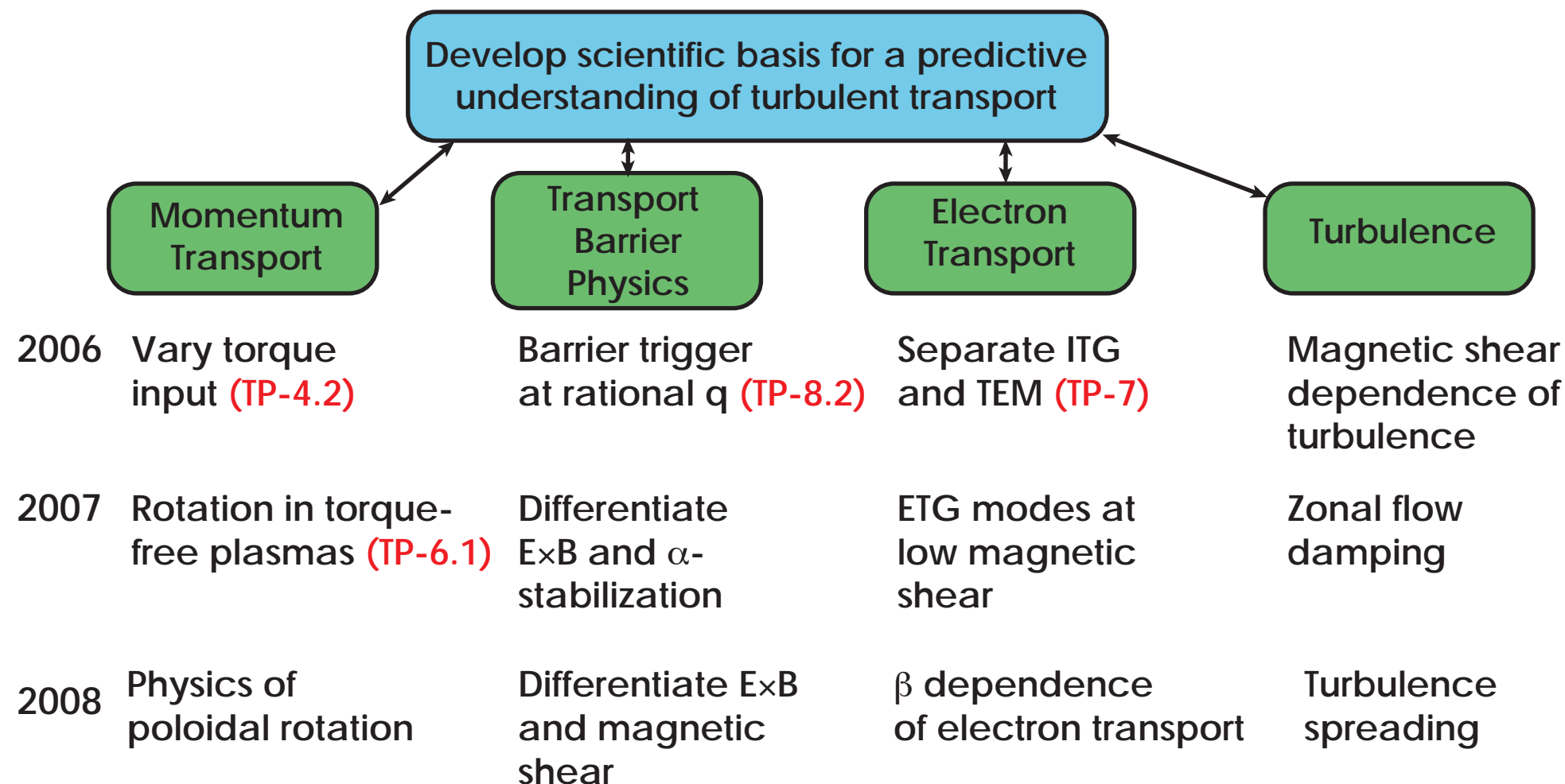
Effect of E x B shear on turbulence

2006-07: Dependence of turbulence on Mach number; separate E x B and α -stabilization

2008: Separate E x B and magnetic shear effects

T5. How are electromagnetics fields and mass flow generated in plasmas?

New Tools and Diagnostics Will Promote Significant Progress Towards a Predictive Understanding of Transport



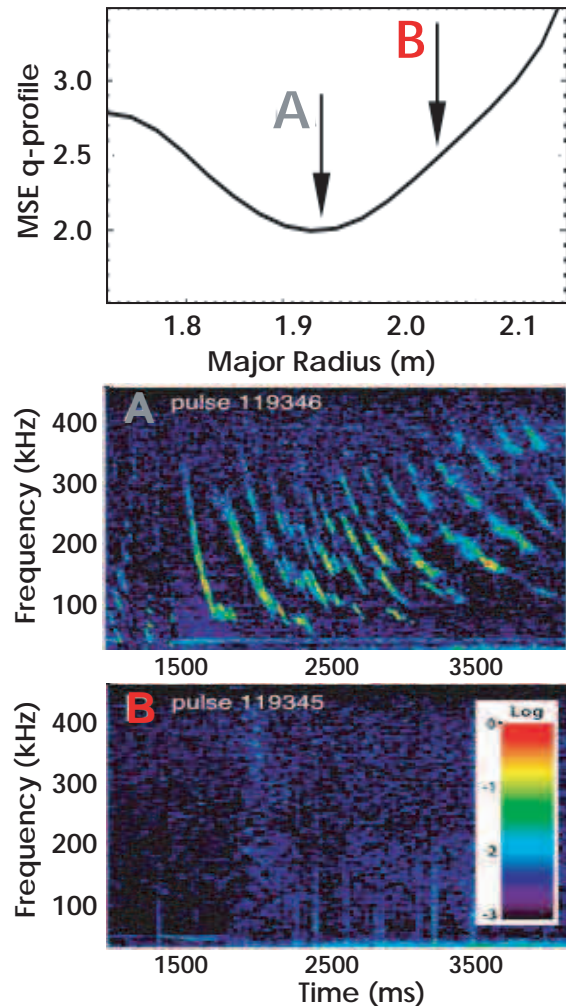
T1. How does magnetic field structure impact fusion plasma confinement?

T4. How does turbulence cause heat, particles, and momentum to escape from plasmas?

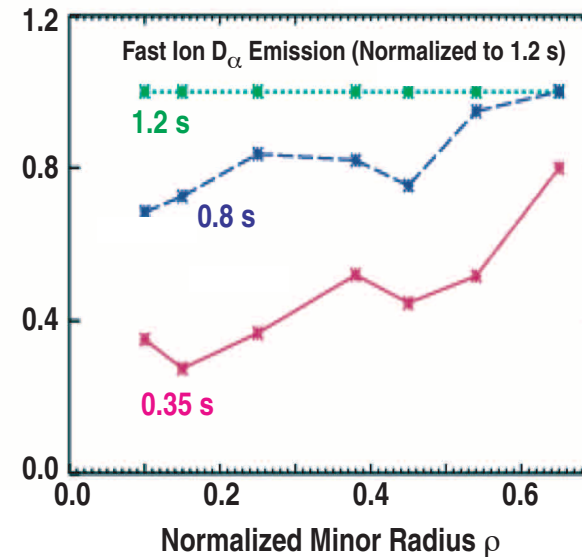
T5. How are electromagnetic fields and mass flows generated in plasmas?

Unique Diagnostic Set Will Allow Detailed Studies of Alfvén Eigenmode Structure and Effect

Fluctuations measurements can localize mode structure



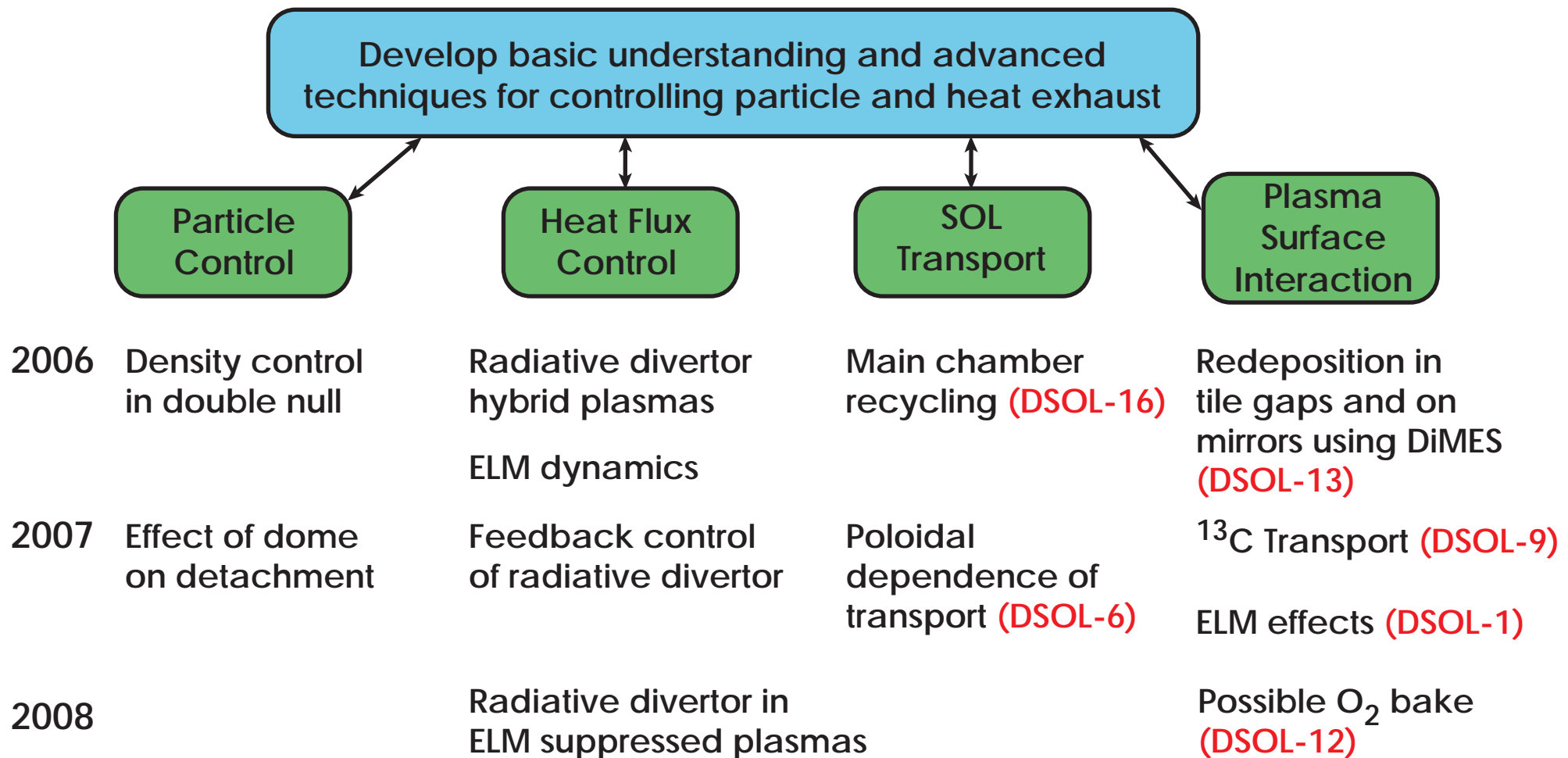
Fast ion profile diagnostic can measure transport from AEs



- 2006-07:
 - Measure effect of TAE modes on fast ion transport; Benchmark models (MDC-9)
- 2008:
 - Use MHD spectroscopy to study Alfvén eigenmode stability

T12: How do high-energy particles interact with plasma?

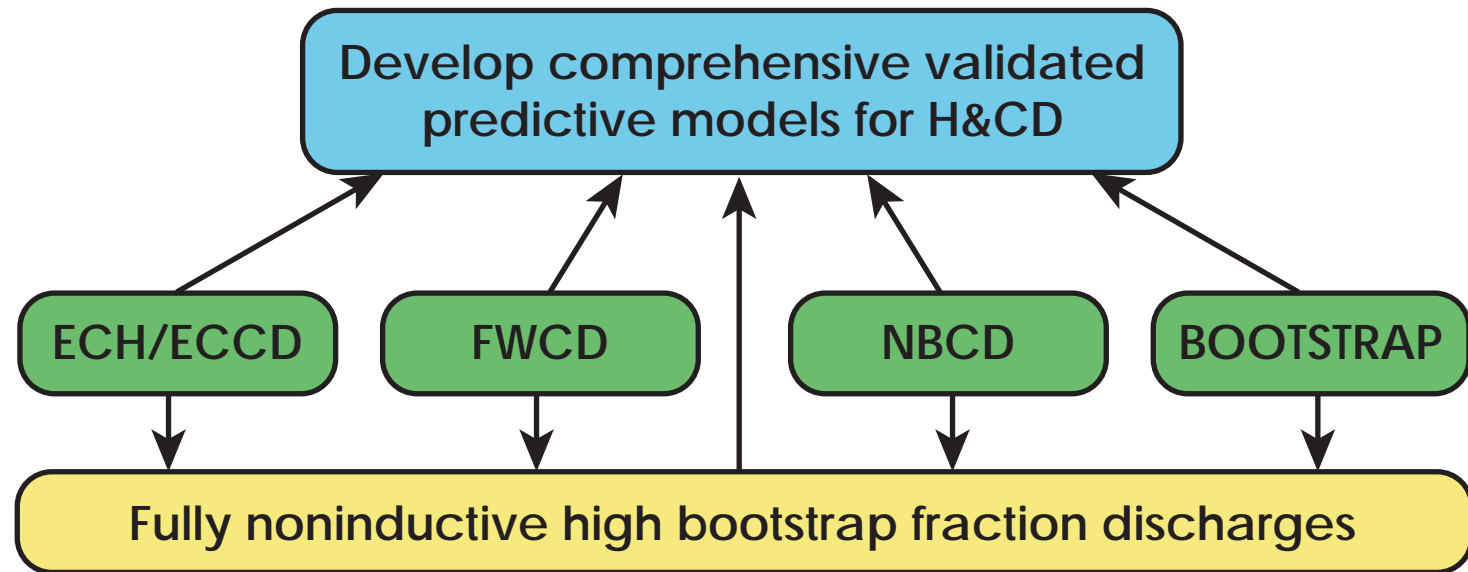
Divertor Research Supports Advanced Tokamak, ITER, and Basic Physics Programs



T5. How are electromagnetic field and mass flows generated in plasmas?

T10. How can a 100-million-degree-C burning plasma be interfaced to its room temperature surroundings?

Experiments in Heating and Current Drive Will Emphasize Tests of Theoretical Models Important in ITER Modeling



ECH/ECCD

FWCD

NBCD

BOOTSTRAP

2006

Validate current drive models using new NBI

2007 Far-off-axis ECCD

Measure high harmonic absorption on beam ions

Test theory in pedestal region

2008

Current drive in AT plasmas

"Alpha channeling"

Test theory in core

T11: How do electromagnetic waves interact with plasma?

DIII-D Research Program Is Closely Aligned with FESAC Priorities Report Overarching Themes

FESAC Priorities Panel

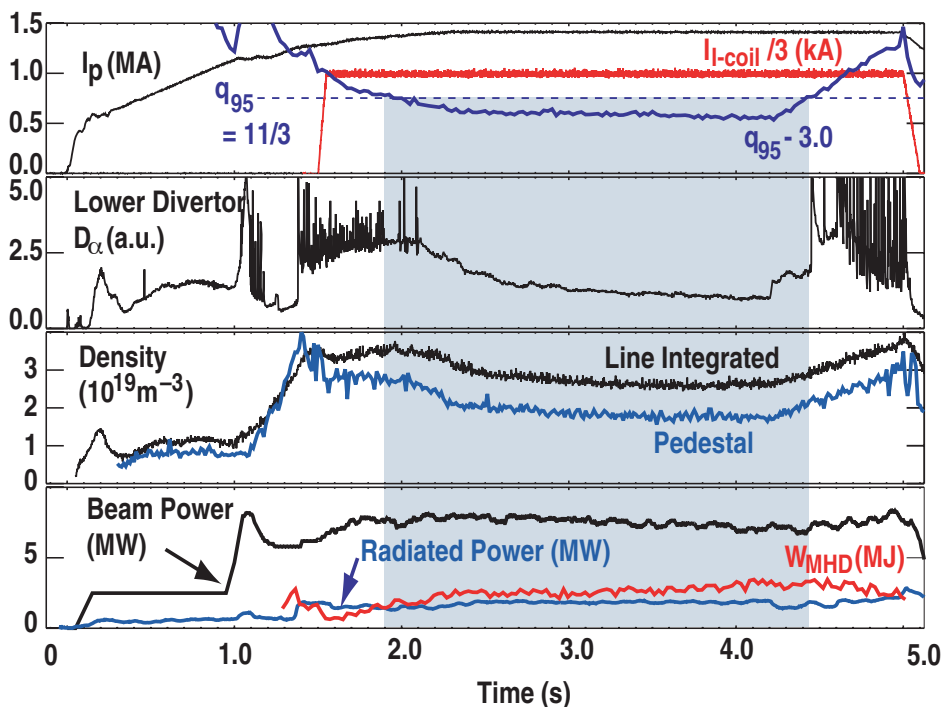
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New Tools Will Allow Detailed Assessment of ELM Control Techniques for ITER

- Experiments indicate RMPs can suppress ELMs without severe degradation in confinement



- 2006-08 goal: Establish the physics basis for RMP and/or QH-mode application to ITER

2006: • Explore mechanisms responsible for RMP-induced increase in particle transport (PEP-17)

- Determine minimum counter vs co-NBI ratio for QH-mode access (PEP-14)

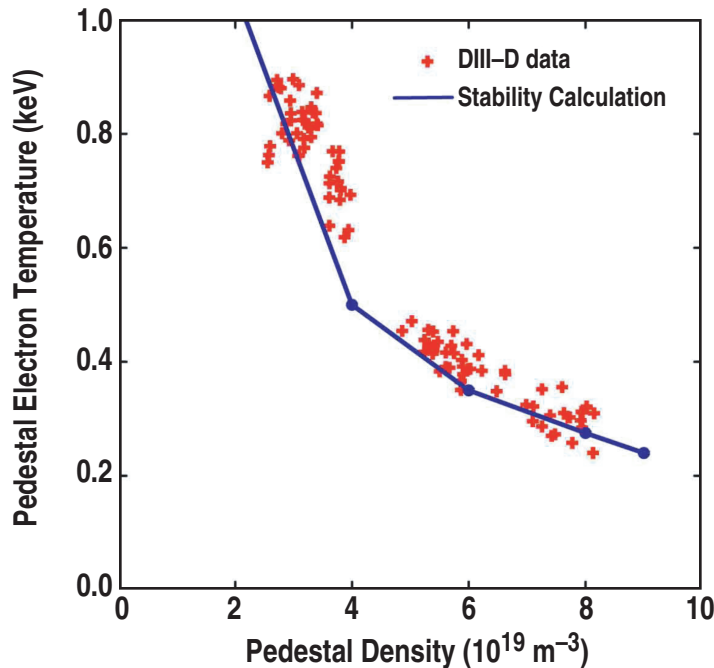
2007: Demonstrate ELM control in ITER-like plasma conditions (shape, collisionality, low rotation)

2008: Benchmark models of ELM control and apply to ITER

T10: How can a 100-million-degree-C burning plasma be interfaced to its room-temperature surroundings?

Pedestal Studies Will Shift Emphasis from Stability Properties to Understanding Transport

- Stability limit from ELITE matches DIII-D data *when width is measured*



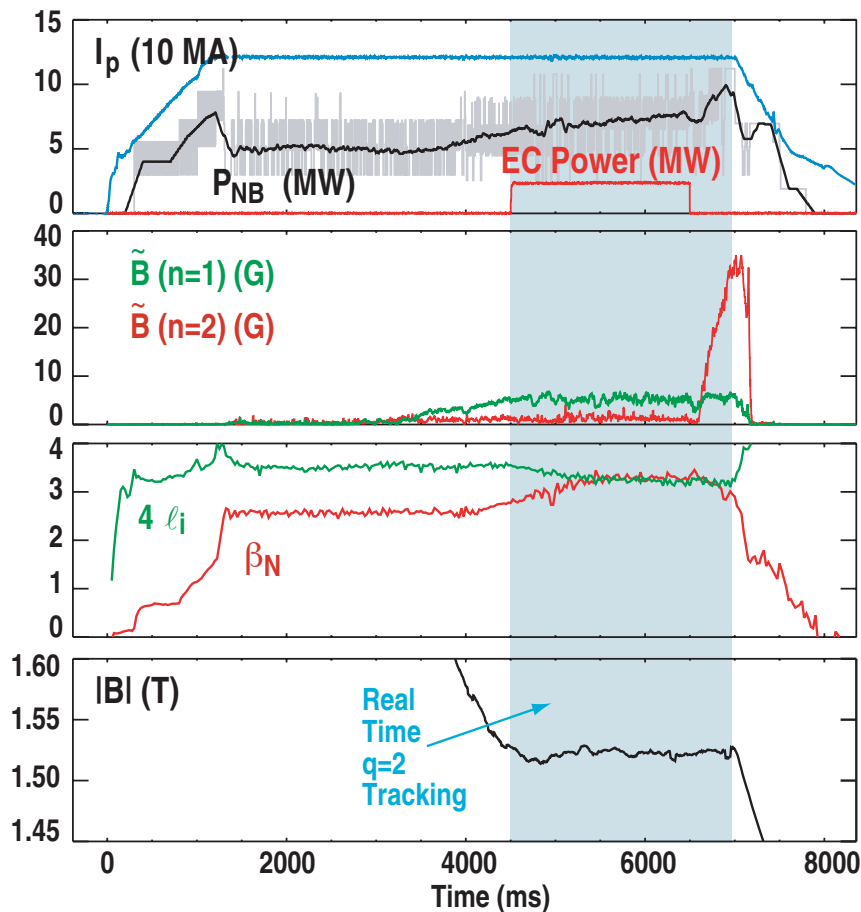
- Prediction of pedestal height requires ability to *predict pedestal width*

- New thrust established in 2006 to address pedestal transport issues
- Plans for 2006-07
 - ρ^* scaling experiment with JET (PEP-2)
 - Engage theorists for development and initial test of theories (TGLF)
- Plans for 2008
 - Detailed tests of pedestal transport theories
 - Correlate pedestal transport with pedestal turbulence measurements

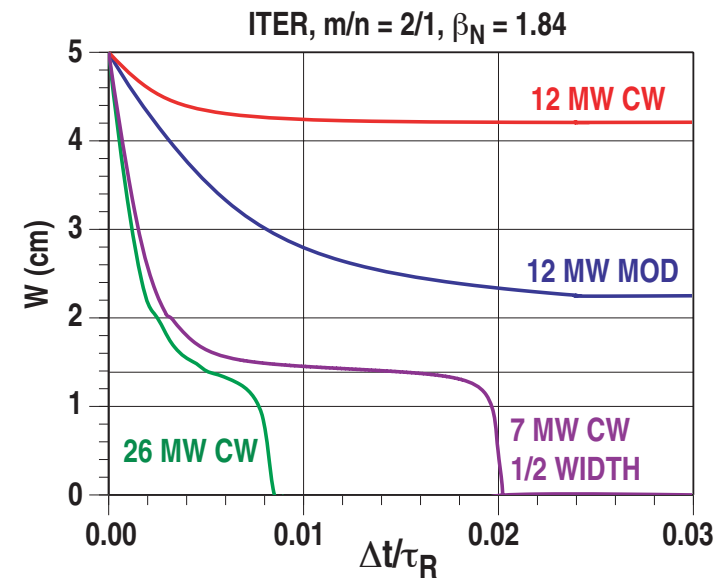
T4: How does turbulence cause heat, particles, and momentum to escape from plasmas?

NTM Experiments are Focused on Providing the Physics Basis for ECCD Stabilization in ITER

- ECCD utilized to suppress $m=2/n=1$ NTM up to no-wall β limit



- Required EC power in ITER sensitive to CD width and modulation



Plans for

- 2006-07:
 - Assess benefit of modulation and current drive width relative to island size (MDC-8)
- 2008:
 - Develop real-time steering and tracking

- T2: What limits the maximum pressure that can be achieved in laboratory plasmas?
- T3: How can external control...be used to improve fusion performance?
- T6: How do magnetic fields in plasmas reconnect and dissipate their energy?

Disruption Studies Will Aim to Avoid, Mitigate, and Characterize Disruptions

- **Avoidance**

- Pre-emptive stabilization of $m=2/n=1$ NTM using ECCD ($\beta \lesssim \beta^{\text{no-wall}}$)
- Feedback stabilization of resistive wall mode ($\beta > \beta^{\text{no-wall}}$)

- **Mitigation**

- Employ new high-flow gas valve to reach Rosenbluth density for suppression of runaway avalanche (2006) (MDC-1, DSOL-11)
- Improved diagnostics for assessing impurity penetration and subsequent transport (2006)
- Develop control algorithms for reliable disruption prediction (2008)

- **Characterization**

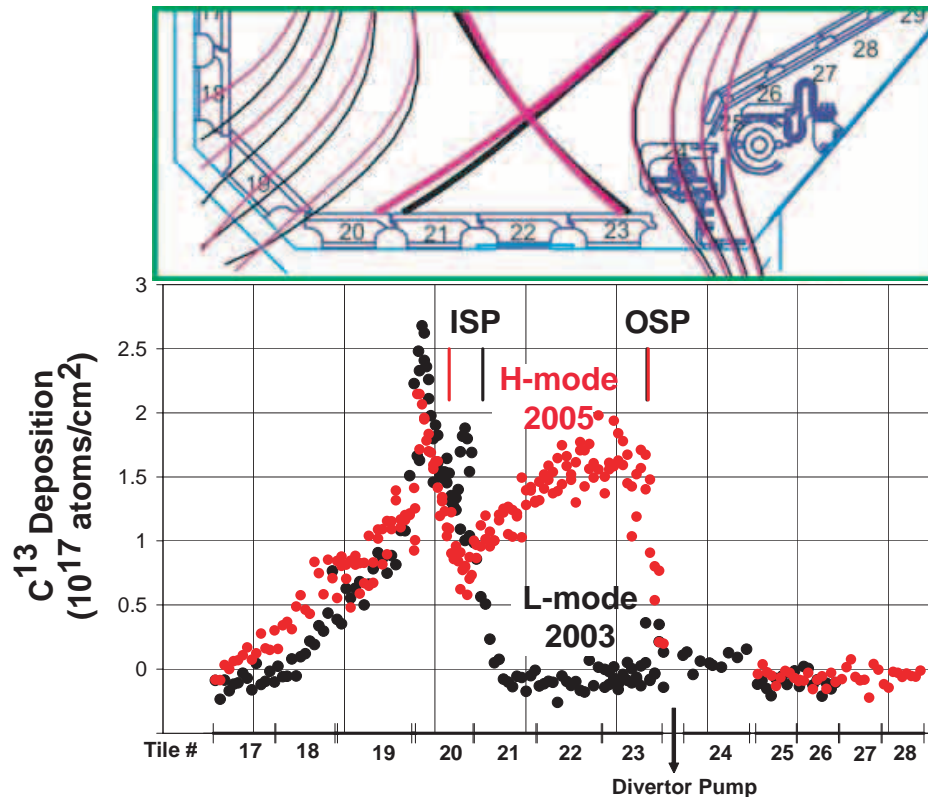
- Characterize disruption energy loss and time scale, including size scaling (in collaboration with JET) (2007)
- Study runaway electron physics (2007 incremental)

T2: What limits the maximum pressure that can be achieved in laboratory plasmas?

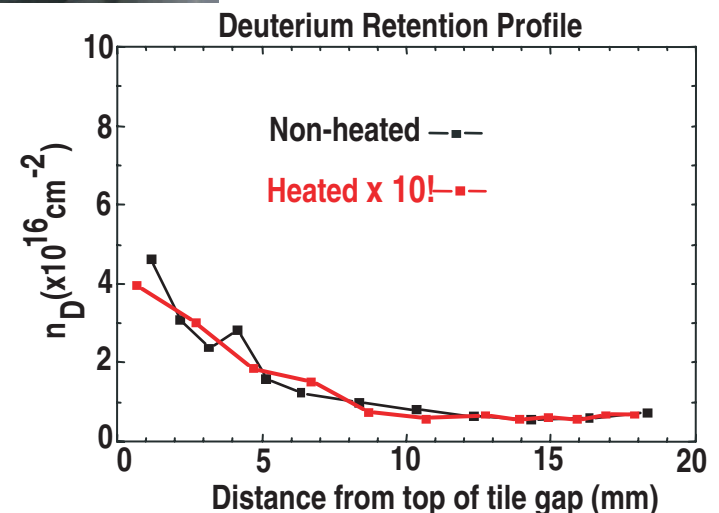
T13: How does the challenging fusion environment affect plasma chamber systems?

Recent Experiments Suggests Tritium Uptake in Carbon Facing Surfaces May be Controllable

- C^{13} experiments show localization of deposition in inner divertor region
- DiMES experiments show large reduction in C and D deposition on heated materials



DiMES configured with simulated tile gap



T10: How can a 100-million-degree-C burning plasma be interfaced to its room temperature surroundings?

T14: What are the operating limits for materials in the fusion environment?

DIII-D Experiments Will Address Key Issues on Tritium Retention in ITER

- Experiments in 2006-08 will focus on:
 - Identifying preferential locations for carbon re-deposition through C^{13} experiments (2007) (DSOL-9)
 - Utilizing DiMES to characterize dependence of carbon re-deposition and hydrogenic retention on material temperature (2006) and plasma conditions (2007) (DSOL-13)
 - Testing methods for removing hydrogen from co-deposited layers (2008) (DSOL-12)

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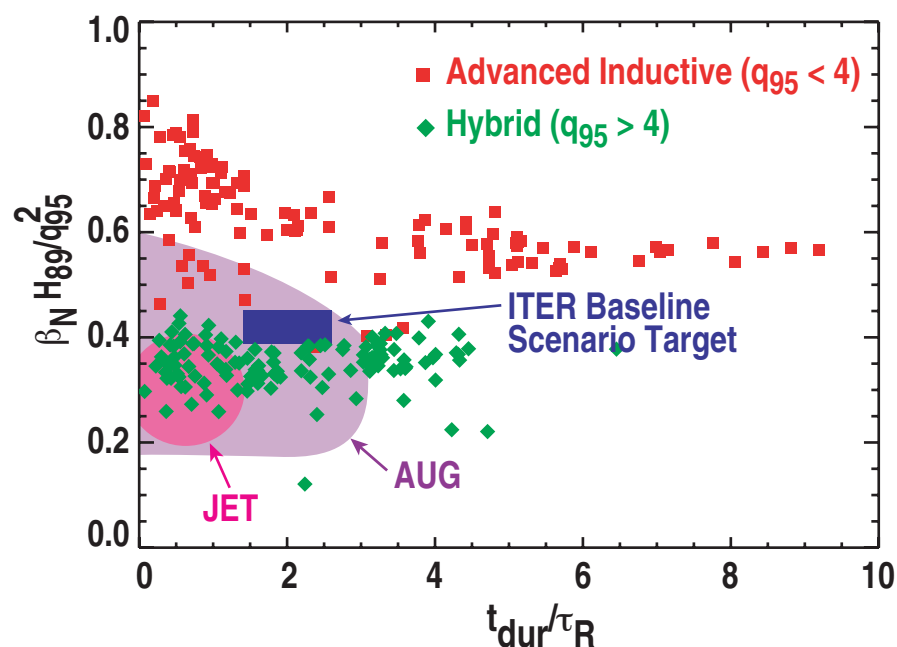
“Hybrid” Development is Now Focusing on Key Transport Issues in Projecting Performance to ITER

- DIII-D is collaborating with ASDEX-Upgrade and JET to establish the basis for “improved” operation in ITER

- New tools will allow assessment of physics important in scaling to ITER

Plan:

- 2006: Utilize balanced NBI to assess role of rotation in improved confinement (TP-4.2)
- 2007: Use higher EC power to assess role of T_e/T_i in improved confinement (TP-3)
- 2008: Demonstrate improved performance in low rotation, ITER-shaped plasma with $T_e \approx T_i$ (TP-2, SSO-2)



T4: How does turbulence cause heat, particles, and momentum to escape from plasmas?

T3: How can plasma self-organization be used to improve fusion performance?

DIII-D's Near-Term Program Will Focus on Control Tool Development for ITER While Longer Term Plan Emphasizes Scenario Demonstration

2006		2008		2010	2012	2014
ITER Timeline		Design Review	Machine Core Set		Day 1 PFC Set	Day 1 H&CD, Control, and Diagnostics Set
ELM Control		Evaluate techniques	Propose design for ITER		Demonstrate ELM solution	Control Tools
Disruptions		Test Gas Jet	Characterize Thermal Loads		Pre-Disruption Detection	
NTM Stabilization		Test ECCD Modulation	Develop Real-Time Steering			
Tritium Retention		¹³ C Transport	Co-deposition with heated walls		Test co-deposit removal techniques	
RWM Stabilization		Test feedback at low rotation	Validate models	Propose design for ITER		
Baseline Scenario		Demonstrate performance	Test predictive models		Refine and validate predictive models	Develop and Test Prototype ITER Simulator
Hybrid Scenario			Validate in reactor-like conditions		Define required control tools	Develop access technique for ITER
Advanced Tokamak		Demonstrate fully non-inductive ops	Evaluate compatibility with ITER hardware set		Demonstrate AT scenario w/o RWM	Develop access technique with ITER Day 1 H&CD Set
Scenario Demonstration						

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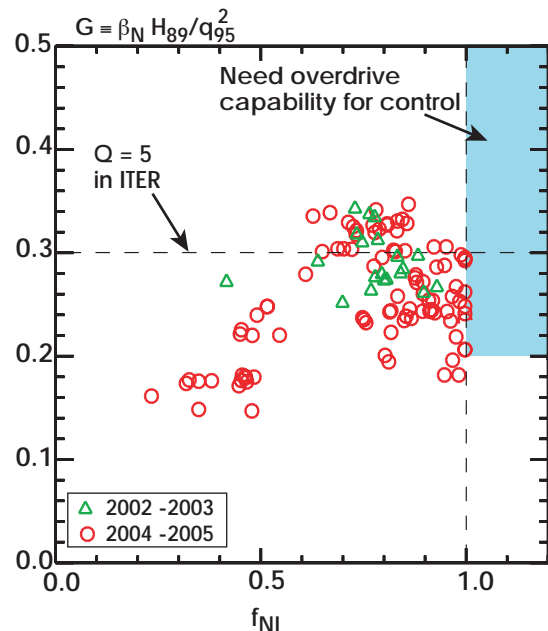
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New Tools Will Allow Physics Exploration and Continued Optimization of Advanced Tokamak Regime

- Performance required for ITER Q=5 steady-state scenario has been demonstrated



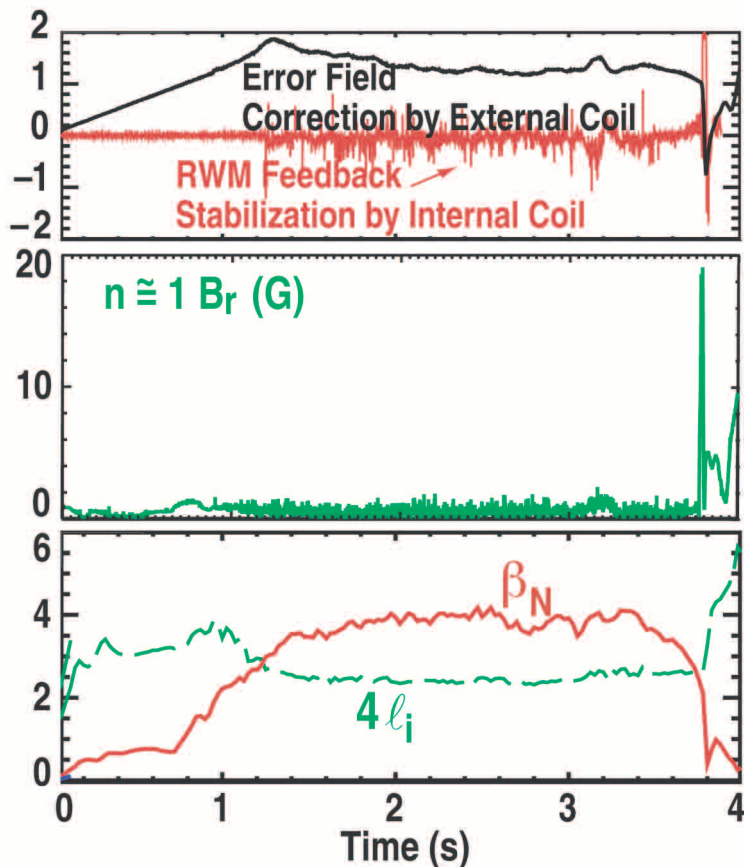
- Limited by ideal stability and lack of independent control of heating and current drive

- New tools address present limitation
 - New divertor allows stronger shaping
 - Increased EC power provides more current drive
 - Fast wave upgrades allow central heating without current drive
- Knowledge learned on DIII-D is being tested on similar experiments on JET, JT-60U, and ASDEX-Upgrade (SSO-1)

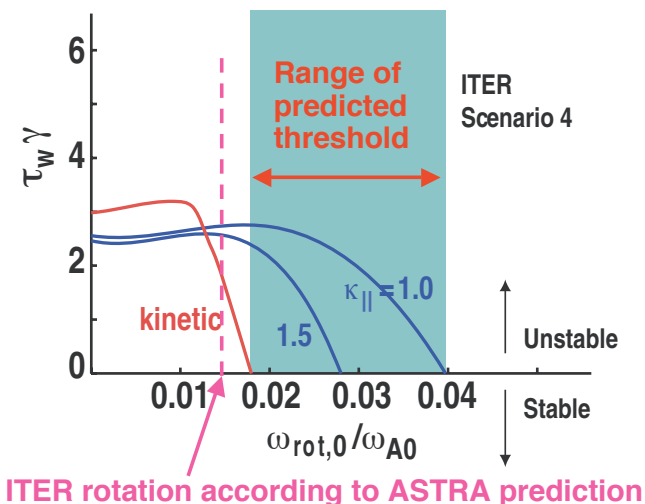
T3: How can external control and plasma self-organization be used to improve fusion performance?

RWM Stabilization Efforts will Focus on Sustaining High β plasmas at Low Rotation

- Rotational RWM stabilization allows operation with $\beta_N \gg \beta_N^{\text{no-wall}}$



- However, ITER rotation expected to be insufficient for stabilization



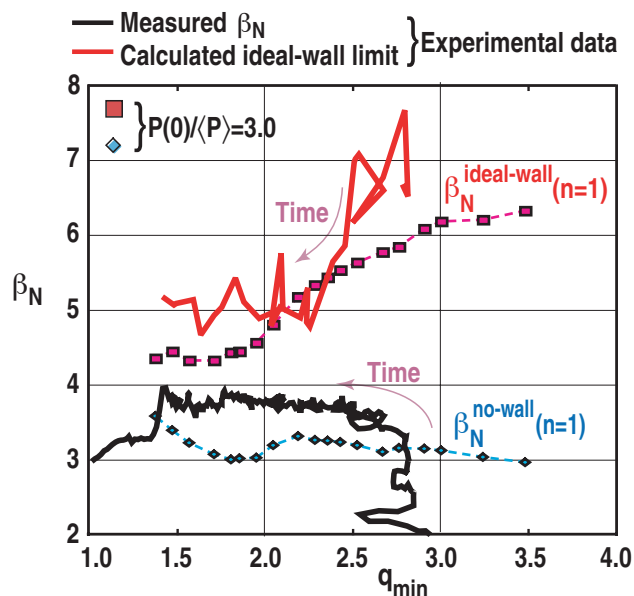
- Plans for 2006-07:
 - Map out RWM stability limit vs. rotation (MDC-2)
 - Demonstrate feedback stabilization in low rotation plasma
- Plans for 2008:
 - Assess benefit of external vs internal coils
 - Benchmark models for use on ITER

T3: How can external control...be used to improve fusion performance?

T2: What limits the maximum pressure that can be achieved in laboratory plasma?

Current Profile Optimization is a Key Element in the Near-Term Advanced Tokamak Research Plan

- Theory suggests increasing gap between $\beta_N^{\text{no-wall}}$ and $\beta_N^{\text{ideal-wall}}$ at high q_{\min}
- Balanced NBI + current profile control will facilitate high q_{\min} , high β operation



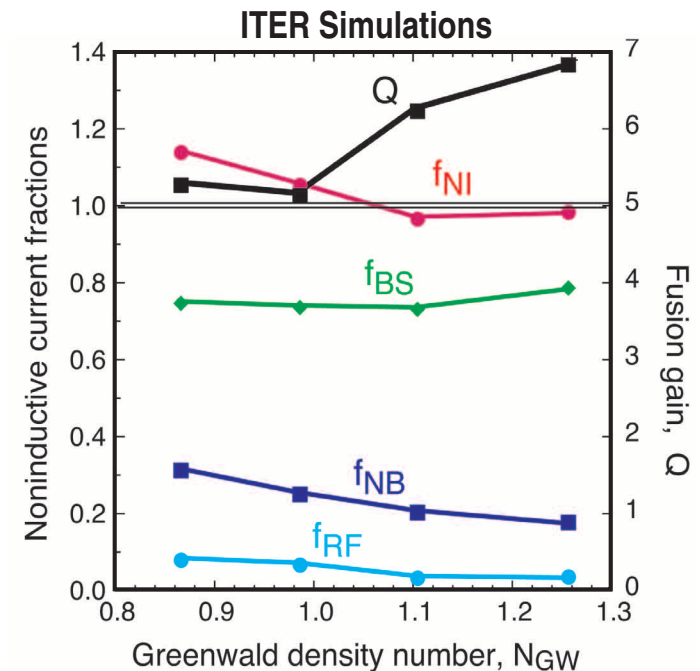
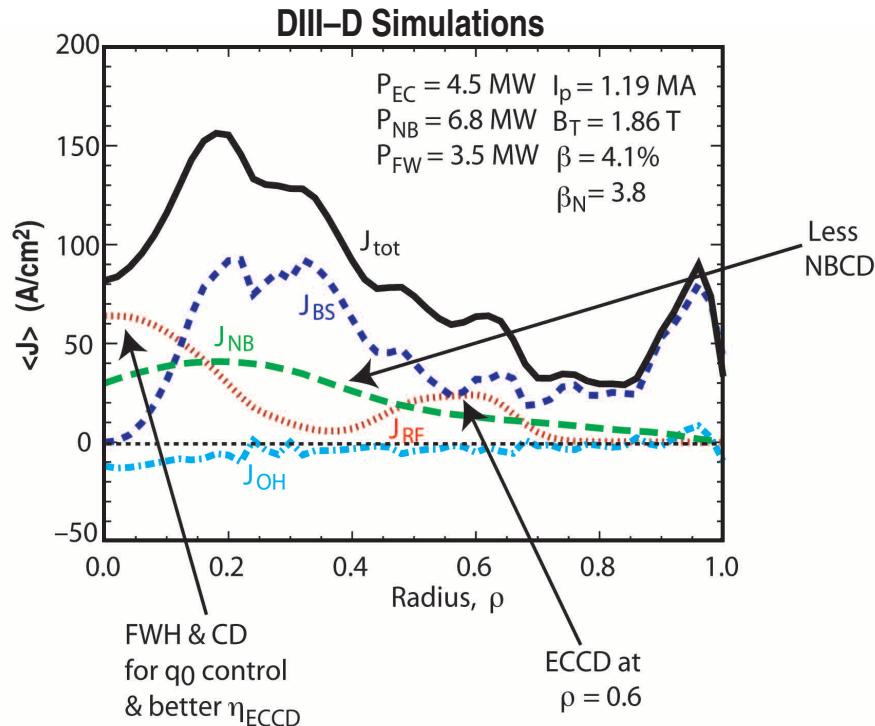
- 2006-07: Survey range of current profiles for optimal transport, stability, and bootstrap fraction (SSO-1.2)
- 2008: Explore $\beta_N \approx \beta_N^{\text{ideal-wall}}$ fully non-inductive operation (SSO-1.1)

Experiment unable to access high q_{\min} at high β
 $\beta \uparrow \Rightarrow \text{NB power} \uparrow \Rightarrow \text{on-axis NBCD} \uparrow \Rightarrow q_{\min} \downarrow$

- T1: How does magnetic field structure impact fusion plasma confinement?
- T2: What limits the maximum pressure that can be achieved in laboratory plasmas?

Modeling Indicates Fully Non-Inductive Operation is Achievable with New DIII-D Tools

- Model uses GLF23 Transport Model and has been benchmarked against experiment
- Same Model Applied to ITER Indicates $Q=5$, Steady-State Operation Achievable with Day 1 H&CD set

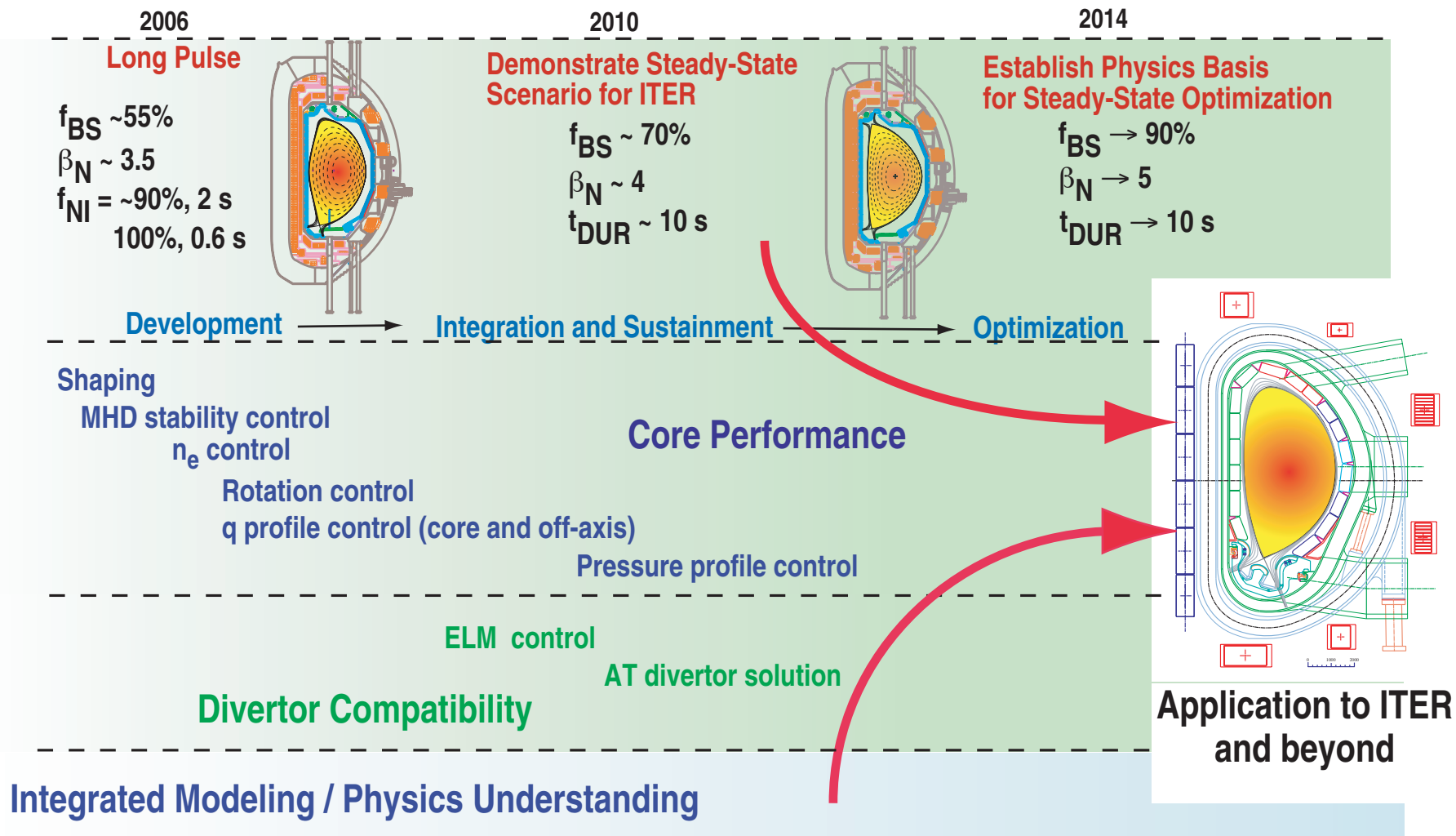


T3: How can external control and self-organization be used to improve fusion performance?

T15: How can systems be engineered to heat, fuel, pump, and confine steady-state or repetitively pulsed burning plasmas?

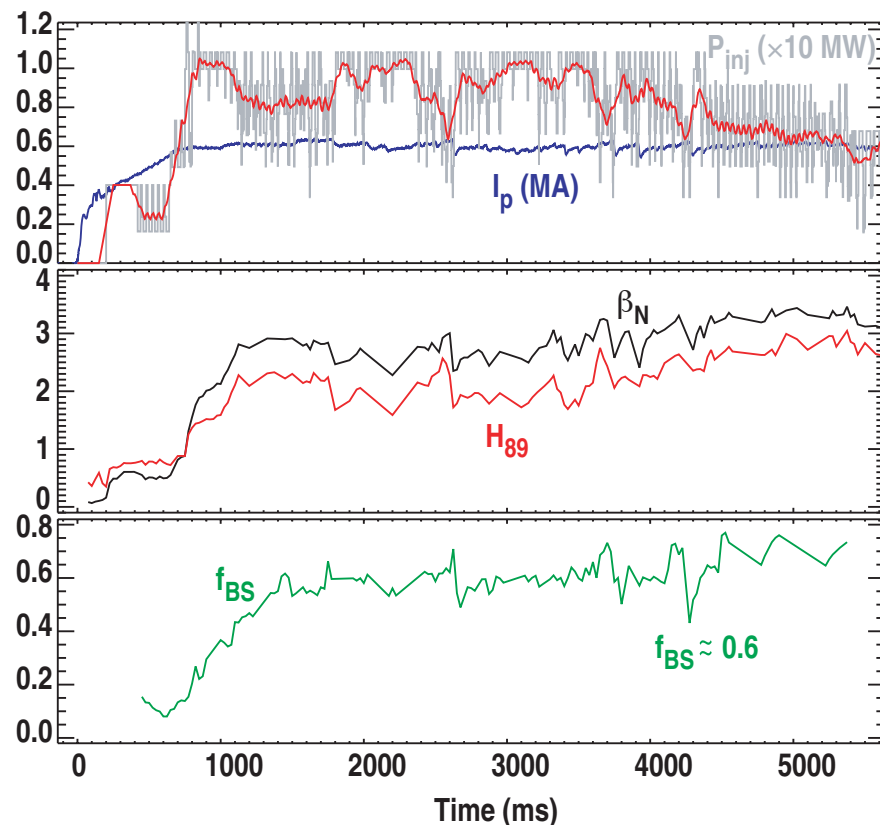
DIII-D is Positioned to Contribute Strongly to Steady-state Scenario Development for ITER

— Plasma control is a key element of the Advanced Tokamak Program —



Separate Experiments Will Explore Physics of Self-Organization in High Bootstrap Fraction Plasmas

- Experiments at high q_{95} (~ 10) have demonstrated fully non-inductive operation



- New tools will allow studies of $f_{BS} \rightarrow 1$ plasmas
 - Balanced NBI to reduce NBCD at high β_N
 - Additional electron heating important to raise bootstrap current

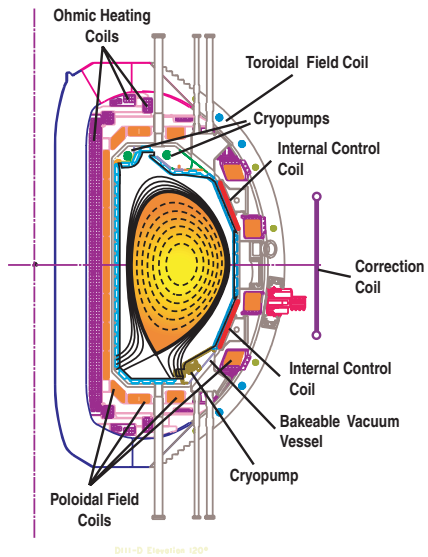
2006-07: Develop fully non-inductive discharges with $f_{BS} \rightarrow 1$ (SSO-1.3)

2008: Study control in high f_{BS} plasmas

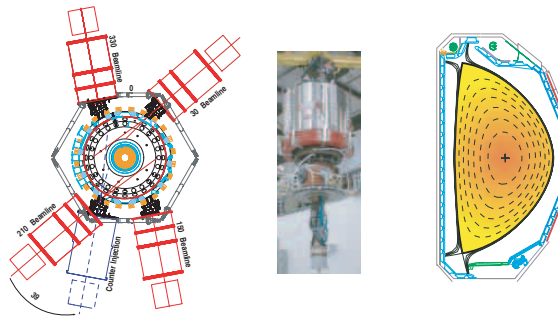
T3: How can... plasma self-organization be used to improve fusion performance?

DIII-D is Well Positioned to Enable the Success of ITER and Advance the Science of Fusion Energy

Machine Versatility



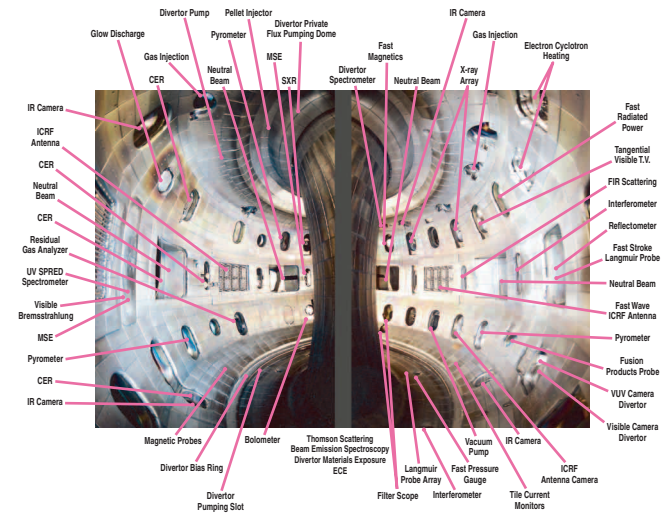
State-of-the-Art Tools



International Research Team



Comprehensive Diagnostics



A unique opportunity to make significant advances towards:

- A predictive understanding of fusion plasmas
- Success of ITER in its baseline mission
- An enriched ITER research program
- Realizing the potential of steady-state tokamak operation

IEA/ITPA Joint Experiments

DIII-D 32 Week Plan, 2006 - 07

ID No	Topical Group	Proposal Title	Devices ²	Ctg	DIII-D 32 Week Plan	AREA Addressed
			Red = Committed, Green = Considering, Blue = Not doing	See bottom	See bottom	
CDB-2	Conf DB & Mod	Confinement scaling in ELMy H-modes: β degradation	AUG, DIII-D, JET, JT-60U, Tore-Supra(L), MAST, NSTX	E/D	—	Transp DIII-D exp complete
CDB-3	Conf DB & Mod	Improving the condition of Global ELMy H-mode and Pedestal databases	AUG, DIII-D, JET, JT-60U, C-Mod	E	—	
CDB-4	Conf DB & Mod	Confinement scaling in ELMy H-modes: ν^* scans at fixed n/n_G	C-Mod, DIII-D, JET, AUG	E	—	
CDB-5	Conf DB & Mod	Effects of inside and vertical pellet launch: ELM behaviour	AUG, DIII-D, JET, HT-7, JT-60U, MAST, HL-	P	✓	IT-1 SC-1
CDB-6	Conf DB & Mod	Improving the condition of Global ELMy H-mode and Pedestal databases: Low A	MAST, NSTX, DIII-D	E	—	
CDB-8	Conf DB & Mod	ρ^* scaling along an ITER relevant path at both high and low beta	JET, DIII-D, C-mod, AUG, NSTX	E	✓✓	Transp IT-2
CDB-9	Conf DB & Mod	Density profiles at low collisionality	JET, DIII-D, C-Mod, AUG, JT-60U, TCV, Tore-Supra, MAST, FTU, NSTX, T-10	D	✓	Transp
TP-1 SSO-1	Transport Physics	Steady-state plasma development		E	✓✓	AT-1
TP-2 SSO-2	Transport Physics	Hybrid Regime development		E	✓✓	IT-2
TP-3	Transport Physics	Determine transport dependence on Ti/Te ratio with high confinement operation	AUG, DIII-D, JET, JT-60U, T-10, TEXTOR, Tore-Supra	E	✓✓	IT-2

IEA/ITPA Joint Experiments

DIII-D 32 Week Plan, 2006 - 07

TP-3.1	Transport Physics	Obtain and sustain high performance operation with Te~Ti, including in hybrid/AT discharges	AUG, DIII-D, JET, JT-60U	P	✓✓	IT-2
TP-4.2	Transport Physics	Low momentum input operation effects on ExB shear and reduced transport	JT-60U, JET, DIII-D, AUG, TCV, FTU, T-10, C-mod	E	✓✓	IT-2 H&CD
TP-5 PEP-14	Transport Physics	QH/QDB plasma studies	DIII-D, JT-60U, MAST, JET, AUG	E	✓✓	IT-1
TP-6.1	Transport Physics	Scaling of spontaneous rotation with no external momentum input	CMOD, DIII-D, JET, JT-60U, Tore-Supra, TCV, FTU, MAST, NSTX, AUG	E	✓✓	Transp H&CD
TP-6.2	Transport Physics	JT-60U/DIII-D Mach number scan similarity experiment	DIII-D, JT-60U	E	✓✓	Transp
TP-6.3	Transport Physics	NBI-driven momentum transport study	DIII-D, JT-60U, NSTX, MAST, AUG	D	✓	Transp H&CD
TP-7	Transport Physics	Measure ITG/TEM line splitting and compare to codes	AUG, DIII-D, T-10, Tore-Supra, JET	E	✓✓	Transp
TP-8.2	Transport Physics	Investigation of rational q effects on ITB formation and expansion	JET, DIII-D, T-10, TEXTOR, TCV, Tore-Supra, FTU, C-Mod	E	✓✓	Transp
TP-9	Transport Physics	H-mode aspect ratio comparison	NSTX, DIII-D, MAST, T-10	E	—	Transp Complete
PEP-2	Pedestal & Edge	Pedestal gradients in dimensionally similar discharges and their dimensionless scaling	JET, DIII-D, ASDEX Upgrade, C-Mod	E	✓✓	SC-1
PEP-4	Pedestal & Edge	Stability analysis with improved edge treatment	AUG, DIII-D, JT-60U, MAST	P	✓	SC-1

IEA/ITPA Joint Experiments

DIII-D 32 Week Plan, 2006 - 07

PEP-5	Pedestal & Edge	Dimensionless identity experiments with JT-60U type II ELMy H-modes in DIII-D	DIII-D, JT-60U		✓	SC-1
PEP-7	Pedestal & Edge	Pedestal width analysis by dimensionless edge identity experiments on JET, ASDEX Upgrade, Alcator C-Mod and DIII-D	JET, ASDEX Upgrade, Alcator C-Mod, DIII-D	E	—	SC-1 JET/C-Mod first
PEP-8	Pedestal & Edge	Parameter similarity studies (Quiescent H-mode regimes)	AUG, DIII-D, JET, JT-60U		✓✓	IT-1
PEP-9	Pedestal and Edge	NSTX-MAST-DIII-D pedestal similarity	DIII-D, MAST, NSTX	E	—	SC-1 complete
PEP-14	Pedestal and Edge	QH/QDB with Co/Counter Rotation Control IN JT-60U AND DIII-D	DIII-D, JT-60U,	E	✓✓	IT-1
PEP-17	Pedestal and Edge	Small ELM regimes at low pedestal collisionality	JT-60U, JET, DIII-D, C-mod	E	✓	IT-1
DSOL-1	Divertor & SOL	Scaling of Type I ELM energy loss	JET, DIII-D ASDEX Upgrade, C-mod	E	✓✓	SC-1 Boundary
DSOL-2	Divertor & SOL	Injection to quantify chemical erosion	TEXTOR, JET, AUG, DIII-D, JT-60U	E	✓✓	Boundary
DSOL-3	Divertor & SOL	Scaling of radial transport	C-mod, ,MAST, DIII-D, JET, AUG, JT-60U	E	✓	Boundary
DSOL-4	Divertor & SOL	Comparison of disruption energy balance in similar discharges and disruption heat flux profile characterisation	JET, DIII-D, ASDEX Upgrade, MAST, Cmod, FTU, JT-60U, TEXTOR	E	✓	Boundary
DSOL-6	Divertor & SOL	Parallel transport in the SOL	DIII-D, JET, JT-60U, MAST and others	D	—	
DSOL-9	Divertor & SOL	¹³ C injection experiments to understand C migration	JET, DIII-D, TEXTOR, ASDEX-Upgrade, JT-60U	E	✓✓	Boundary

IEA/ITPA Joint Experiments

DIII-D 32 Week Plan, 2006 - 07

DSOL-11	Divertor & SOL	Disruption mitigation experiments	DIII-D, JT-60U, Tore Supra, JET (early '06), Alcator C-Mod (spring '06), TEXTOR, AUG	E	✓✓	Stab
DSOL-12	Divertor & SOL	Oxygen wall cleaning	TEXTOR, HT-7, DIII-D, AUG	E	✓	Boundary
DSOL-13	Divertor & SOL	Deuterium codeposition with carbon in gaps of plasma facing components	ASDEX Upgrade, TEXTOR, DIII-D, Tore-Supra, C-Mod, JT-60U	E	✓✓	Boundary
DSOL-16	Divertor & SOL	Determination of the poloidal fueling profile	DIII-D, AUG	E	✓✓	Boundary
MDC-1	MHD, Disruptions & Control	Disruption mitigation by massive gas jets See DSOL-11	DIII-D, JT-60U, Tore Supra, JET (early '06), Alcator C-Mod (spring '06), TEXTOR, AUG	E	✓✓	Stab
MDC-2	MHD, Disruptions & Control	Joint experiments on resistive wall mode physics	DIII-D, JET (experiments scheduled Feb 06), NSTX, JT-60U, AUG and TEXTOR	E	✓	IT-4
MDC-3	MHD, Disruptions & Control	Joint experiments on neoclassical tearing modes (including error field effects)	C-Mod, JET, AUG, DIII-D (sufficient data exist)	E	✓	Stab
MDC-4	MHD, Disruptions & Control	Neoclassical tearing mode physics - aspect ratio comparison	AUG, MAST, NSTX, DIII-D	E	—	Stab
MDC-5	MHD, Disruptions & Control	Comparison of sawtooth control methods for neoclassical tearing mode suppression	AUG, DIII-D, JET, NSTX, TCV and HL2A, C-Mod, FTU	E	✓	Stab

IEA/ITPA Joint Experiments

DIII-D 32 Week Plan, 2006 - 07

MDC-6	MHD, Disruptions & Control	Low beta error field experiments	C-Mod, TEXTOR, MAST, DIII-D, NSTX, JET(done)	E	✓	Stab
MDC-7	MHD, Disruptions & Control	Improving NTM modelling/ extrapolation to ITER	AUG, DIII-D, JET, JT-60U, MAST	P	✓	Stab IT-3
MDC-8	MHD, Disruptions & Control	Current drive prevention/stabilisation of NTMs	JET, AUG, JT-60U, DIII-D, FTU, C-mod	E	✓✓	IT-3
MDC-9	MHD, Disruptions & Control	Fast ion redistribution by beam driven Alfvén modes and excitation threshold for Alfvén cascades	JT-60U, JET, DIII-D, NSTX, MAST, AUG	E	✓	Stab
SSO-1.1	Steady-State Operation	Document performance boundaries for steady state target q-profile	JET, AUG, DIII-D, JT-60U, C-Mod	E	✓✓	AT-1
SSO-1.2	Steady-State Operation	Qualify other q-profiles for steady state operation	JT-60U, JET, HT-7, DIII-D, C-Mod	E	✓✓	AT-1
SSO-1.3	Steady-State Operation	Control of high bootstrap plasmas	DIII-D, JET, Tore-Supra, JT-60U, TCV, AUG	E	✓✓	AT-1 H&CD
SSO-2.1	Steady-State Operation	Complete mapping of hybrid scenario	JET, JT-60U, DIII-D, AUG, NSTX, C-mod	E	✓✓	IT-2
SSO-2.2	Steady-State Operation	MHD effects on q-profile and confinement for hybrid scenarios	AUG, JET, DIII-D, JT-60U, NSTX, C-mod	E	✓✓	IT-2
SSO-2.3	Steady-State Operation	ρ^* dependence on confinement, transport and stability in hybrid scenarios	DIII-D, JET, AUG, JT-60U, C-mod, NSTX	E	✓✓	IT-2

IEA/ITPA Joint Experiments

DIII-D 32 Week Plan, 2006 - 07

SSO-3	Steady-State Operation	Real-time q-profile control in hybrid and steady state scenarios	JET, Tore-Supra, AUG, DIII-D, JT-60U, HT-7, C-Mod	P	✓✓	AT-1 IT-2
SSO-4	Steady-State Operation	Documentation of the edge pedestal in advanced scenarios	AUG, JET, DIII-D, JT-60U, C-Mod	D	✓✓	SC-1 IT-2
DIAG-1	Diagnostics	Assessment of the effect of noise on vertical velocity measurement	JET, JT-60U, TCV, NSTX, AUG, C-Mod	P	✓	Stab
DIAG-2	Diagnostics	Environmental tests on Diagnostic First Mirrors (FMs)	T-10, TEXTOR, Tore-Supra, JET, DIII-D, TCV, AUG, LHD, FTU, NSTX, C-Mod	E	✓✓	Boundary

E = Well defined, accepted joint experiment.

D = Needs further definition

P = Programmatic activity, not joint experiment

✓✓

Significant Program Element

✓

Will contribute

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No Effort in 2006 - 07